

WHAT IS CLAIMED IS:

1. A method of decreasing the concentration of nitrogen oxides in a combustion flue gas comprising:

a. forming a combustion flue gas in a combustion zone, the combustion flue gas comprising nitrogen oxides;

b. providing overfire air and droplets of a solution, particles or a gas of a selective reducing agent in a burnout zone, the droplets or particles having a small average size to promote fast reduction of the nitrogen oxides;

c. mixing the overfire air and the selective reducing agent with the combustion flue gas in the burnout zone at a temperature above an optimal temperature range for reduction of the nitrogen oxides;

d. as the combustion flue gas heats the overfire air and the selective reducing agent to the optimal temperature range, reducing the nitrogen oxides with the reducing agent, and

e. continuing to increase the temperature of the overfire air and the selective reducing agent beyond the optimal temperature range with the flue gas.

2. The method of claim 1 wherein the optimal temperature range during step (d) occurs in a brief period

of less than 0.3 second and the reduction of the nitrogen oxides occurs during the brief period.

3. The method of claim 1 wherein the small average size of droplets and particles is no greater than 60 microns.

4. The method of claim 1 wherein the small average size of droplets or particles is no greater than 50 microns.

5. The method of claim 1, wherein the step of mixing the overfire air and the selective reducing agent with the combustion flue gas occurs as the flue gas is in a temperature range of about 2500°F to about 2000°F, and the optimal temperature range is of about 1600°F to about 2000°F.

6. The method of claim 1, wherein the step of providing the overfire air and the selective reducing agent comprises adding the selective reducing agent to the overfire air concurrently with injecting overfire air into the combustion flue gas in the burnout zone.

7. The method of claim 1, wherein the step of providing the overfire air and the selective reducing agent comprises adding the selective reducing agent to the overfire air prior to injecting the overfire air into the burnout zone.

8. The method of claim 1, wherein the selective reducing agent is injected into a center portion of a stream of overfire air.

9. The method of claim 1, wherein the selective reducing agent is injected into an upper portion of a stream of overfire air.

10. The method of claim 1, wherein the selective reducing agent reduces the nitrogen oxides when the flue gas is at an average temperature above 2000°F, and the mixture of flue gas, overfire air and reducing agent is at an average temperature of about 1600°F to about 2000°F.

11. The method of claim 1, wherein the solution is an aqueous solution.

12. The method of claim 1, wherein the selective reducing agent is provided in a stoichiometric ratio of about 0.4 to about 10, wherein the stoichiometric ratio is a ratio of moles of atoms of nitrogen in the selective reducing agent to moles of atoms of nitrogen in the nitrogen oxides.

13. The method of claim 12, wherein the stoichiometric ratio is in a range of 0.7 to 3.

14. The method of claim 1, wherein the droplets are formed to have an initial average size distribution with fewer than about 10% of the droplets having a droplet size greater than about 1.5 times an average droplet size.

15. The method of claim 1, wherein the mixture of overfire air and droplets of a solution or gas of the

selective reducing agent is formed by injecting the droplets into the overfire air.

16. The method of claim 1, wherein the concentration of the selective reducing agent in the solution is about 5% by weight to about 90% by weight.

17. The method of claim 1, wherein the overfire air is injected through at least two ports located at different levels with selective reducing agent injected through an upper port of said at least two ports.

18. The method of claim 1, wherein the overfire air is a recirculating O₂ enriched flue gas.

19. A method of decreasing the concentration of nitrogen oxides in a combustion flue gas, comprising:

(a) forming a combustion flue gas in a combustion zone, the combustion flue gas comprising nitrogen oxides;

(b) providing overfire air and droplets of an aqueous solution, particles or gas of a selective reducing agent in a burnout zone, the droplets or particles having an initial average size of less than 50 microns;

(c) introducing the overfire air and the selective reducing agent into combustion flue gas in the burnout zone, and

(d) decreasing the concentration of nitrogen oxides in the flue gas by reducing the nitrogen oxides with the selective reducing agent.

20. The method of claim 19, wherein the selective reducing agent is selected from a group consisting of urea, ammonia, ammonium salts of organic acids, ammonium salts of inorganic acids, and mixtures thereof.

21. The method of claim 19, wherein the step of providing the overfire air and the selective reducing agent comprises adding the selective reducing agent to the overfire air concurrently with injection of the overfire air into the burnout zone.

22. The method of claim 19, wherein the step of providing the overfire air and the selective reducing agent comprises adding the selective reducing agent to the overfire air prior to the introduction of the overfire air into the burnout zone.

23. The method of claim 19, wherein the selective reducing agent, and overfire air, and flue gas form a mixture having a temperature briefly in a range of about 1600°F to about 2000°F and said decrease in the concentration occurs while the mixture temperature is in said range, and the flue gas in the burnout zone has a temperature above 2000°F.

24. The method of claim 19, wherein the overfire air is introduced through at least two ports located at different

levels of said burnout zone, and said selective reducing agent is injected through an upper port of said at least two ports.

25. A combustion apparatus for combusting comprising:

a boiler defining an enclosed flue gas path having a combustion zone and a burnout zone, wherein flue gas is formed in the combustion zone and the combustion flue gas comprising nitrogen oxides;

a fuel injector aligned with an introducing fuel into the combustion zone and a combustion air injector aligned with and introducing air into the combustion zone;

an overfire air system adjacent the burnout zone comprising an overfire air port adjacent the burnout zone and through which overfire air flows into the burnout zone and

a nitrogen reagent injector having an outlet aligned with the overfire air system and injecting nitrogen reagent gas or small droplets into said overfire air, wherein said small droplets have an average diameter of no greater than 50 microns.

26. The combustion apparatus as in claim 25 further comprising a reburn zone in the boiler between the combustion zone and burnout zone, and wherein said reburn zone comprises a fuel injector aligned with and introducing fuel into the reburn zone.

27. The combustion apparatus as in claim 25 wherein the outlet of the nitrogen reagent injector discharges the nitrogen reagent proximate to the overfire air port.

28. The combustion apparatus as in claim 25 wherein the outlet of the nitrogen reagent injector discharges the nitrogen reagent upstream of the overfire air port in an overfire air stream of the overfire air system.

29. The combustion apparatus as in claim 25 wherein the nitrogen reagent injector discharges the nitrogen reagent along a centerline of an overfire air stream.

30. The combustion apparatus as in claim 25, wherein the overfire air is injected through at least two ports located at different levels with the nitrogen reagent injector aligned with an upper port of the at least two ports.